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Toward Understanding the Smart Home Automation Concept Using KNX Protocol

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----------Abstract----------

This paper shows the KNX application model as the basis of the smart home automation concept implementation. The distribution details of lighting system in a mosque using the KNX protocol is presented. The paper discusses the distribution of lighting technique. The distribution is done according to the Egyptian code. A safety design for this building is constructed. It compares the distribution technique with and without KNX protocol.

Keywords: lighting, flat, distribution, KNX, cost, optimization.

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I. INTRODUCTION

In a distribution system there are wiring rules which briefly states: [2]-Each power line holds certain amount of wattage, (Normal loading is 1200 Watt or less and maximum loading is 1500 watt).- Care about each line length to minimize the cost for each by connecting floor parts which are undependable on each other and near to each other.
- The acceptable number of lighting wires is 5 or 6 lines for each floor.
- Each lighting wire should be hidden in the wall by using certain tubes.
- Each lighting switch should be in obvious place;-
- Distribution banal place should be in a place which achieve the most economical wires length and not deform the wall view.

Lighting control is one of the basic functions of KNX Protocol. A big advantage of KNX is its high level of flexibility. Accordingly, changes to the lighting and lighting Control in terms of its function, usage and floor plan can usually be realized by simple reprogramming.

There are three basic control types: [5]
1. Switching all types of luminaries via switch actuators
2. Dimming of certain luminaries via universal dimmer actuators
3. Dimming of certain luminaries via Light Controllers/Switch/Dim Actuators

-Switch actuators: are been used with KNX unlike conventional switching via light switches or pushbuttons with installation relays. Switch actuators are so-called intelligent relays.
-Dimming actuators: Dimming options for the lighting are important and are an ever more desired function.
-Two important factors play an important role here:
1. Comfort, e.g. pleasant lighting while dining that suits the situation and mood
2. Cost-effectiveness, power consumption and cost reduction through:

– Dimming of the lighting to suit the incidence of external light
– Extended service life of the luminaries through reduced intensity of the switch on brightness
– Reduced brightness for different area usages, e.g.

A different level of brightness is required than during training sessions.

2. Classification of Studying the Distribution System:

1- Distribution system in Wedding hall& Office& Area9 in ground floor.
2-Distribution system in Area3& Women ablution & Entrance & Conference & women bathrooms in ground floor.

3-Distribution system in praying hall for women& Stairs in ground floor.
4-Distribution system in Wedding hall2& Wedding hall3 in First floor.
5. The distribution system in the Stairs in First floor.
6. The distribution system in a Basement floor.
7-Study the wiring method of each floor of mosque without KNX.
8-Study the wiring method of each floor of mosque with KNX protocol.
9-Calculation of energy cost with KNX protocol.
10-Calculation of energy cost without KNX protocol.
11-Comparison between cost of each place in mosque with& without KNX protocol.

Two types of lamps (Incandescent& fluorescent) are used. The number of lamps in each place are calculated by using we factors of each type.

Factors of Incandescent (in) lamp are (2):-

Factor of lamp	**0.2**
Efficiency	**14**
Maintenance	**0.8**
Utilization	**0.45**

Factors of Fluorescent (f) lamp are (2):-

Factor of lamp	**0.068**
Efficiency	**56**
Maintenance	**0.8**
Utilization	**0.33**

Each lux according to type of place (2).3-

Place	lux
Bathroom	**300**
Shower room	**300**
Corridor	**150**
Conference room	**150**
Praying hall	**150**
Women ablution	**300**
Men ablution	**200**
Stairs	**120**
Entrance	**300**
Area3&Area9	**150**
Area4	**200**
Office	**150**

There are laws that are used to get number of lamps:-
1-Wattage=factor of lamp *lux*area
2-No. of lamp=(lux*area)\(efficiency*maintenance*utilization*wattage of lamp)

***3. The distribution system in the Ground floor*:-**

The distribution system in Wedding hall&Office&Area9 in ground floor.

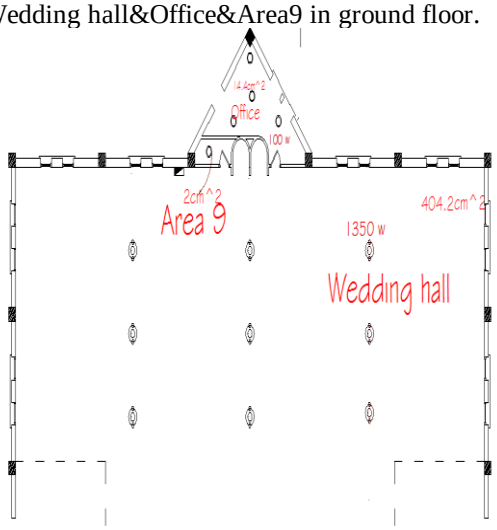

Fig.1 illustrates Wedding hall & Office &Area9 in Ground floor.

Table 1.1 illustrates area, lamp type, wattage of lamp, number of lamp and actual wattage for each place.

Place	Area (Cm^2)	Lamp type	Wattage (Watt)	Wattage Of lamp	No. of lamp	Actual Wattage (Watt)
Wedding hall	**404.2**	**In**	**12126**	**150**	**81**	**12150**
Office	**14.4**	**In**	**432**	**100**	**5**	**500**
Area9	**2**	**In**	**60**	**100**	**1**	**100**

The distribution system in Area3&Women ablution& Entrance& Conference& women bathrooms.

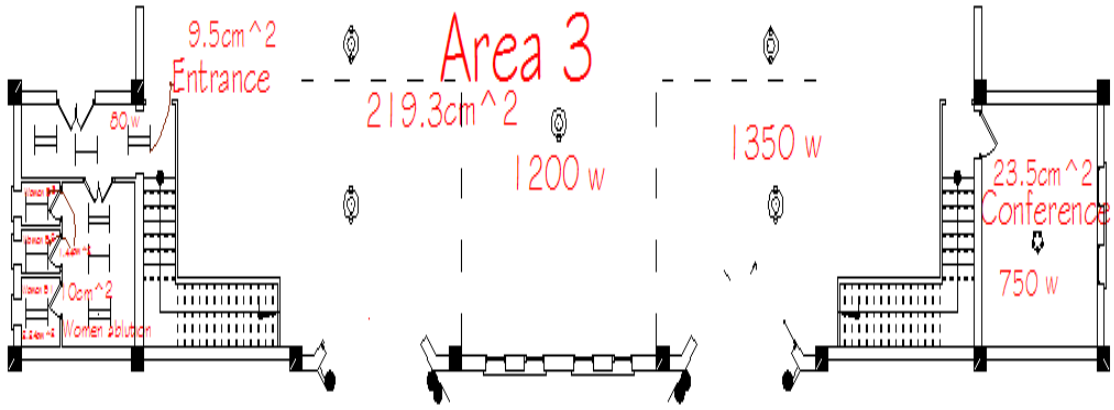

Fig.2 illustrates Area3&Womenablution&Entrance&Conference&Women bathrooms in Ground floor.

Table 2.1 illustrates area, lamp type, wattage of lamp, number of lamp and actual wattage for each place

Place	Area (Cm^2)	Lamp type	Wattage (Watt)	Wattage Of lamp	No. of lamp	Actual Wattage (Watt)
Area3	219.3	In	6579	150	44	6600
Women ablution	10	F	204	40	5	200
Entrance	9.5	F	193.8	40	5	200
Conference	23.5	In	705	150	5	750
WomenB1	2.24	F	45.696	40	2	80
WomenB2&B3	1.44	F	29.376	40	1	40

The distribution system in praying hall for women& Stairs in ground floor.

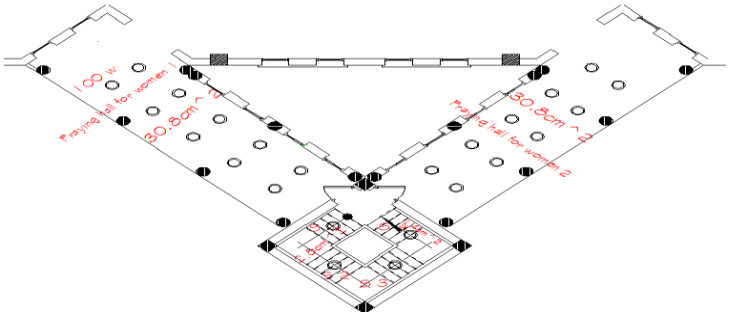

Fig.3 illustrates Praying hall for women1, 2&stairs in Ground floor.

Table 3.11 illustrates area, lamp type, wattage of lamp, number of lamp and actual wattage for each place

Place	Area (Cm^2)	Lamp type	Wattage (Watt)	Wattage Of lamp	No. of lamp	Actual Wattage (Watt)
Praying hall1&Praying hall2	30.8	In	924	100	10	1000
S1&S2&S3	2.8	In	62.4	100	1	100
S4	1.4	In	33.6	100	1	100

5. The distribution system in a First floor.

The distribution system in Wedding hall1& Wedding hall2 in First floor.

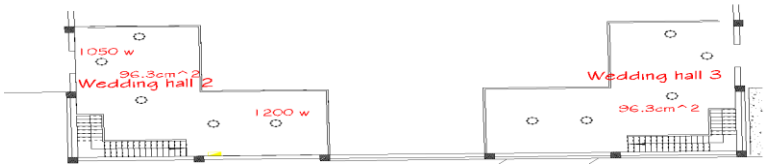

Fig.4 illustrates wedding hall in first floor.

Table 4.1 illustrates area, lamp type, wattage of lamp, number of lamp and actual wattage for each place.

Place	Area (Cm^2)	Lamp type	Wattage (Watt)	Wattage Of lamp	No. of lamp	Actual Wattage (Watt)
Wedding hall2&Wedding hall2	96.3	In	5778	150	39	5850

The distribution system in S1&S2&S3&S4 in First floor.

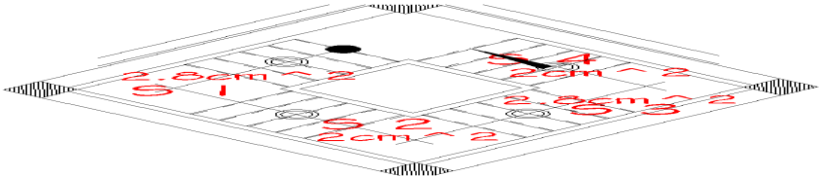

Fig. 5 illustrates stairs in First floor

Table 5.111 illustrates area, lamp type, wattage of lamp, number of lamp and actual wattage for each place.

Place	Area (Cm^2)	Lamp type	Wattage (Watt)	Wattage Of lamp	No. of lamp	Actual Wattage (Watt)
S1&S3	2.8	In	67.2	100	10	1000
S2&S4	2	In	48	100	1	100

6 The distribution system in a Basement floor.

The distribution system in the Basement floor.

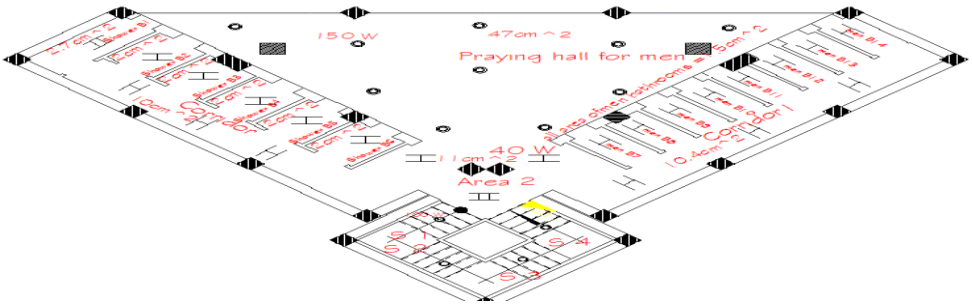

Fig.6 illustrates The First floor.

Table 6.1 illustrates area, lamp type, wattage of lamp, number of lamp and actual wattage for each place.

Place	Area (Cm^2)	Lamp type	Wattage (Watt)	Wattage Of lamp	No. of lamp	Actual Wattage (Watt)
ShowerB2&B3& B4&B5&B6	2	F	40.8	40	1	40
ShowerB1	2.7	F	55.08	40	2	80
Corridor1	10.4	F	106.08	40	3	120
Corridor	10	F	102	40	3	120
Area2	11	F	149.6	40	4	160
Praying hall for men	47	In	1410	150	10	1500
S1&S4	2	In	48	100	1	100
S2&S3	2.8	In	67.2	100	1	100

7 Study the wiring method of each floor of mosque without& with KNX protocol.

Study the wiring method of each floor of mosque without KNX protocol.

A-Wiring of Ground floor without KNX:-

A-1 wiring of Wedding hall& Office& Area9.

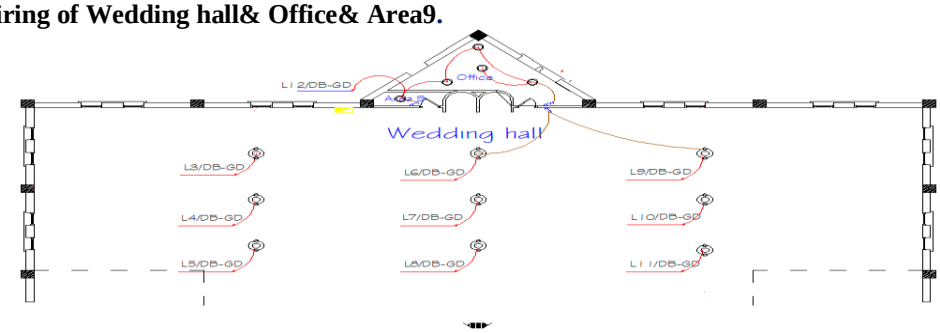

Fig.A-1 illustrates wiring of wedding hall&office&area9

The following table illustrates power of each line

Line	Power	current
L3,L4,L5,L6,L7,L8,L9,L10 L11\DB-GD	**1350 W**	**6.14 A**
L12\DB-GD	**500**	**2.3 A**

Table A-1

A-2 wiring of Area3&Conference&Entrance&Women bathrooms& Women ablution

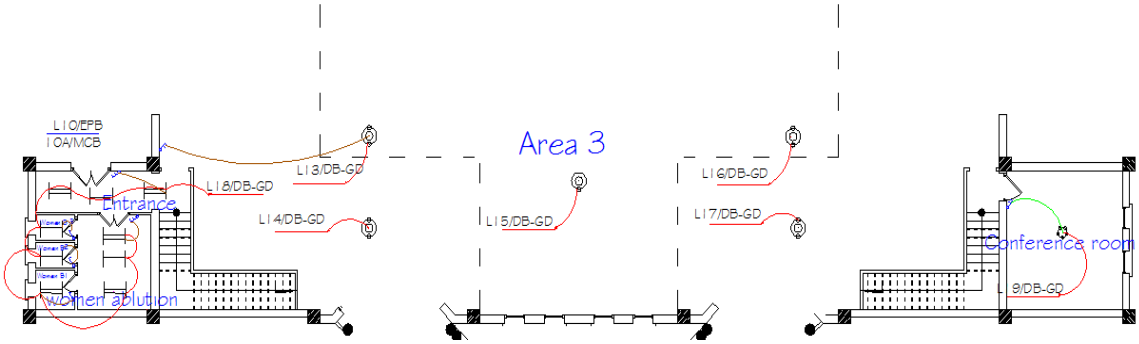

Fig.A-2 illustrates wiring of area3&conference&entrance&women bathrooms&women ablution

The following table illustrates power of each line

Line	Power	Current
L13,L14,L16,L17\DB-GD	**1350 W**	**6.14 A**
L15\DB-GD	**1200 W**	**5.5 A**
L18\DB-GD	**560 W**	**2.55 A**
L19\DB-GD	**750 W**	**3.41 A**

Table A-2

A-3 wiring of praying hall for women1& praying hall for women2& stairs.

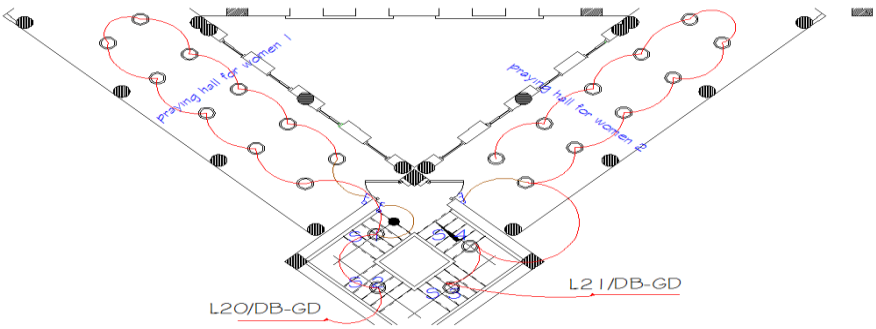

Fig.A-3 illustrates wiring of praying hall1,2&stairs

The following table illustrates power of each line

Line	Power	Current
L20,L21\DB-GD	**1200 W**	**5.5 A**

Table A-3

Sum of current for ground floor= 31.54 A

B-Wiring of First floor without KNX:-

B-1 Wiring of wedding halls.

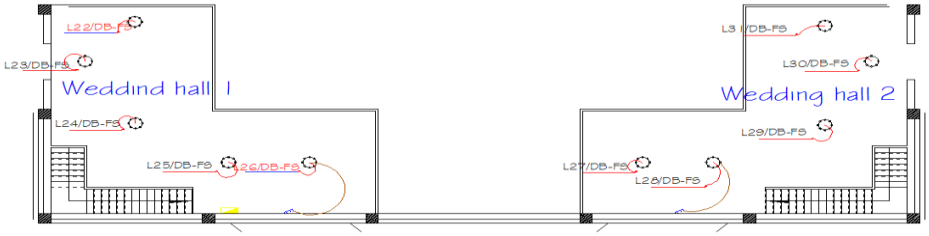

Fig.B-1 illustrates wiring of wedding hall1,2

The following table illustrates power of each line

Line	Power	Current
L22,L24,L25,L26,L27,L28, L29,L31\DB-FS	1200 W	5.5 A
L23,L30\DB-FS	1050 W	4.8 A

Table B-1

B-2 Wiring of Stairs

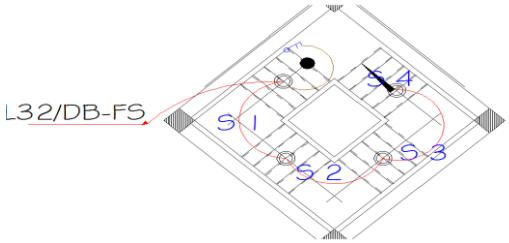

Fig.B-2 illustrates wiring of stairs

The following table illustrates power of each line

Line	Power	Current
L32\DB-FS	400 w	1.8 A

Table B-2

C-Wiring of Basement floor without KNX:-

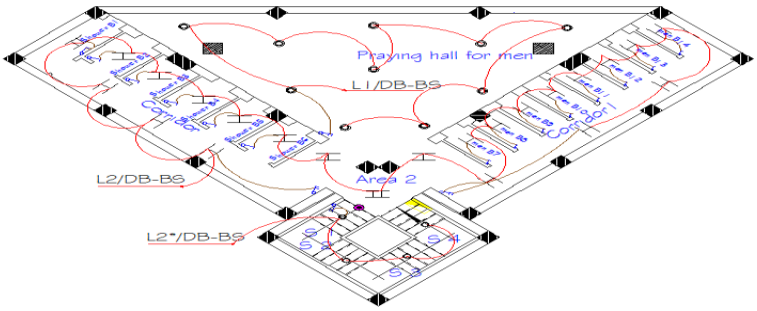

Fig.C-1 illustrates wiring of praying hall for men& shower rooms& men bathrooms&area2&stairs

The following table illustrates power of each line

Line	Power	Current
L1\DB-BS	1500 W	6.82 A
L2\DB-BS	1000	5.68 A
L2*\DB-BS	400 w	1.8 A

Table C-1

Study the wiring method of each floor of mosque with KNX protocol.

Installer Benefits bye using KNX protocol.
· Meeting subsequent customer desires
· Extends standard functions thanks to the integration of KNX components
· Eliminates costly bus engineering
· Tested solutions
· Fast commissioning
· Easy to reconfigure and expand
· Settings can be adjusted at any time and the system expanded without costly demolition or rewiring
· All devices are connected to a common bus line

Client benefits by using KNX protocol.
· Match investment to actual needs
· Lower energy costs
· 'one' system approach
· Optimum climatic conditions
· Increased level of comfort
· Maintenance cost reduced

There are main steps to adjust KNX Protocol:-
1- First step:
1.1 -Connecting all loads which have the same controlling action.
1.2-Determine the most suitable
actuator according to reliability and cost.
1.3-Refering each line to its channel of its actuator.
(EXP: Sw3/4: means this line will be connected to the switch actuator no. 3 at it's forth channel).

2-Second step:
2.1- After determining the most reliable actuators and arranging it in the distribution panel.
2.2-Connect each load to the channel of its actuator.
2.3-Determine the suitable power supply to connect it to the panel. (By assuming that each actuator takes 10 MA (ref), and the rating of the power supplies ranges **is** (160 MA, 230 MA, 640 MA),
Hint: It is ok to connect to power supplies in the same panel for one cable but if the length of this cable not less than 200 M.
2.4- Only one cable is exit from the panel passing by all switches and sensors as In Fig. A*-4
Hint: this connection might be in tree, line or star but never be loop.
The order, the signal will rotate in the loop and will not reach the actuator).

Third step:
Inserting a description for the switches operation as shown in fig. A*-7.

Actuators that are used [7]

Switch actuator REG-K/8x230/6

Blind actuator REG-K/4x/6

Universal dimming actuator REG- K/230/500 W

Movement detector

A* Wiring of Ground floor with KNX:-
First step:-
\- As shown in figure (A*-1) it is used five dimming actuators (DM1,DM2,DM3,DM4,DM7) which has one channel to reduce light and hence reduce energy at different times in day in (L1,L2,L3,L4,L40)respectively.
-It is used switch actuator(SW.1) which has eight channels(ch.)to switch loads(L8 on ch.1,L12 on ch.2,L10 on ch.3,L9 on ch.4,L11 on ch.8) on and off.
-It is used also blind actuator (BD1) which has four channels (ch.) to control movement of blinds (L18 on ch.1, L17 on ch.2, L16 on ch.3) up and down.

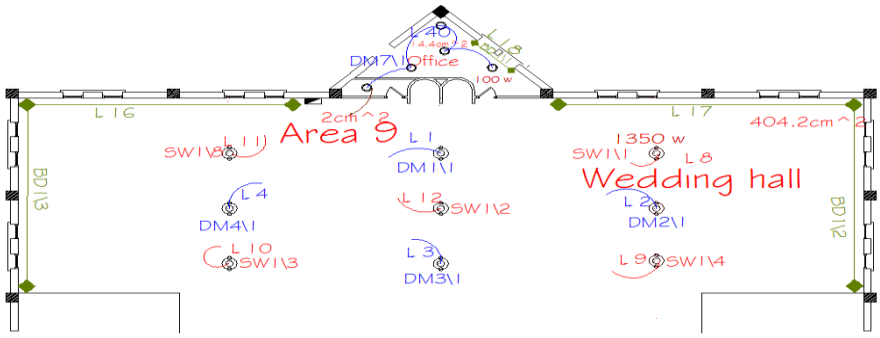

Fig. A*-1 illustrates controlled loads and actuator type that was used in each load.

-As shown in figure (A*-2) it is used three dimming actuators (DM5,DM6,DM8)each one has one channel to reduce light and hence reduce energy at different times in day in (L5,L6,L34)respectively.
-It is used switch actuator(SW.1) which has eight channels(ch.)to switch loads(L14 on ch.5,L13 on ch.6,L15 on ch.7) on and off, and switch actuator(SW.2) which has two channels(ch.) to switch
Loads (entrance, women bathrooms, women ablution on ch.1) on and off.
-It is used a movement detector to sense movement.
-It is used also blind actuator (BD1) which has four channels (ch.) to control movement of blinds (L19 on ch.4) up and down.

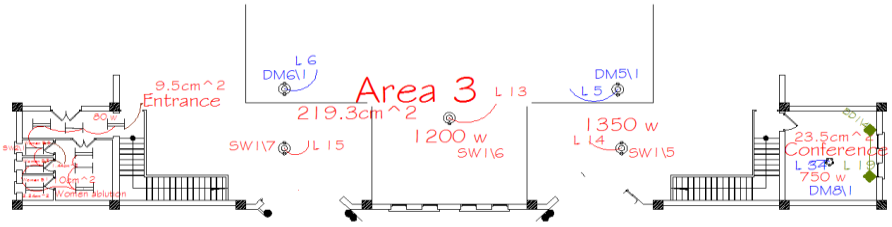

Fig. A*-2 illustrates controlled loads and actuator type that was used in each load

-As shown in figure (A*-3) it is used two dimming actuators (DM9,DM10)each one has one channel to reduce light and hence reduce energy at different times in day in (L23,L22)respectively.

-It is used also switch actuator (SW.2) which has two channels (ch.) to switch load(stairs on ch.2)on and off.
-It is used also blind actuator (BD2) which has two channels (ch.) to control movement of blinds (L21 on ch.1, L20 on ch.2) up and down.

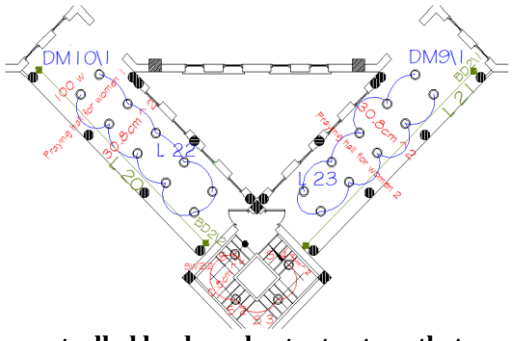

Fig. A*-3 illustrates controlled loads and actuator type that was used in each load.

The following table illustrates wattage and number of channels in each type of actuator &function of each switch in ground floor.

Actuator type			Connection power maximum			Number of channels		
Switch actuator 1(sw.) Switch actuator 2(sw.)			1380(In) Watt 1800(F), 2000(In) Watt			8 2		
Dimming actuator 1,2,3,4.5.6(DM) Dimming actuator8,9,10(DM)			1600(In) Watt 1000(In)			1 1		
Dimming actuator 7(DM)			500(In) Watt			1		
Blind actuator 1(BD)			----			4		
Blind actuator 2(BD)			----			2		
Switch No.	Sw1	Sw1	Sw1	Sw1	Sw1	Sw1	Sw1	Sw1
Operation name	Dim. Up 1	Dim. Down1	Dim. Up 2	Dim. Down2	Dim. Up 3	Dim. Down3	Dim. Up 4	Dim. Down 4
loads								
L1 in wedding hall	**	**						
L2 in wedding hall			**	**				
L3 wedding hall					**	**		
L4 in wedding hall							**	**
	Sw2	Sw2	Sw2	Sw2	Sw2	Sw2	Sw2	Sw2
	Curtain up	Curtain Down	Dim. Up 5	Dim. Down5	Dim. Up 6	Dim. Down6	Sw. on	Sw. off
L5 in area 3			**	**				
L6 in area 3					**	**		
L8 in wedding hall							**	**
L9 in wedding hall							**	**
L10 in wedding hall							**	**
L11 in wedding hall							**	**
L12 in wedding hall							**	**
L13 in area 3							**	**
L14 in area3							**	**
L15 in area3							**	**
L16 in wedding hall	**	**						
L17 in wedding hall	**	**						
	Sw3	Sw3	Sw3	Sw3	Sw4	Sw4	Sw5	Sw5
	Curtain UP2	Curtain Down 2	Dimm. Up	Dimm. Down	Sw. On	Sw. Off	Sw. On	Sw. Off
L18 in office,area9	**	**						
L40 in office,area9			**	**				
WomenB1					Off	Off	Off	Off
WomenB2					Off	Off	**	**
WomenB3					**	**	Off	Off
Women ablution					Off	Off	Off	Off
	Sw6	Sw6	Sw7	Sw7	Sw8	Sw8	Sw8	Sw8
	Sw. On	Sw. Off	Sw. On	Sw. Off	Dimm.	Dimm.	CurtainUp	Curtain

					Up	Down		Down
WomenB1	**	**	Off	Off				
WomenB2	Off	Off	Off	Off				
WomenB3	Off	Off	Off	Off				
Women ablution	Off	Off	**	**				
L20 praying hall for women1							**	**
L22 praying hall for women1					**	**		
	Sw9	Sw9	Sw9	Sw9	Sw10	Sw10	Sw10	Sw10
	Dimm. Up	Dimm. Down	Curtain Up	Curtain Down	Dimm. Up	Dimm. Down	Curtain Up	Curtain Down
L21 praying hall for women2			**	**				
L23 praying hall for women2	**	**						
L34 in conference					**	**		
L19 in conference							**	**
	Sw11	Sw11			S1			
	Sw.on	Sw.off			Dete-cts mov-ement			
Stairs ground floor	**	**		Entrance	**			
				WomenB1	Off			
				WomenB2	Off			
				WomenB3	Off			
				Women ablution	Off			

Note:-
** It means main function of each switch
Sw. it is abbreviation for switching
Dimm. It is abbreviation for dimming

Second step:

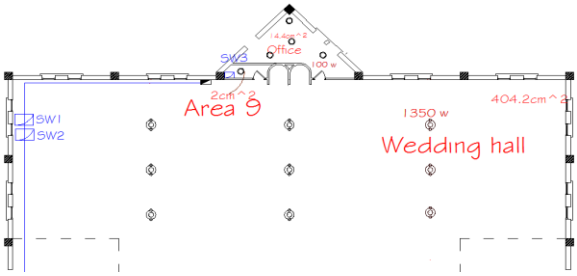

Fig. A*-4 illustrates a cable from SW.1 to SW.2 to SW.3

Fig. A*-5 illustrates a cable from SW.3 to S1 to SW.4 to SW5 to SW6 to SW7 to SW.10

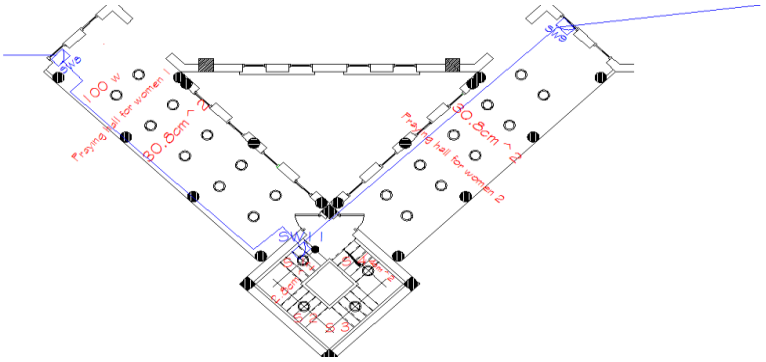

Fig. A*-6 illustrates a cable from control panel to switches (SW.9, SW.8)

Third step:

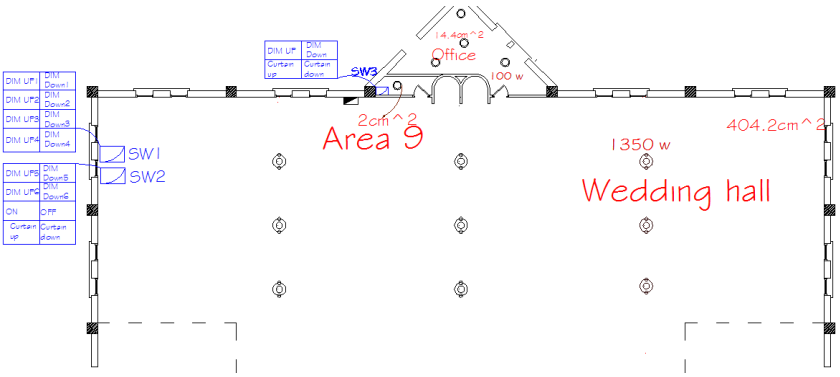

Fig. A*-7 illustrates function of each switch

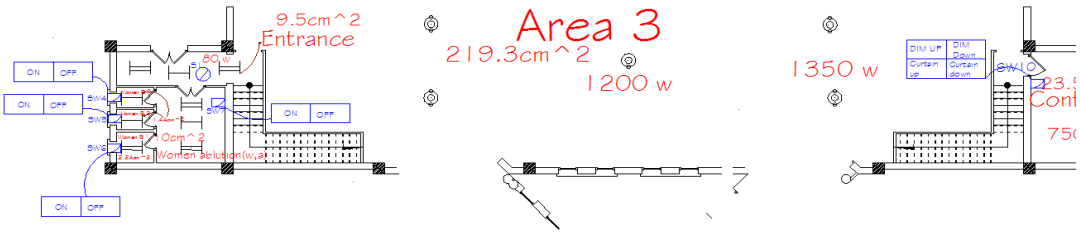

Fig. A*-8 illustrates function of each switch

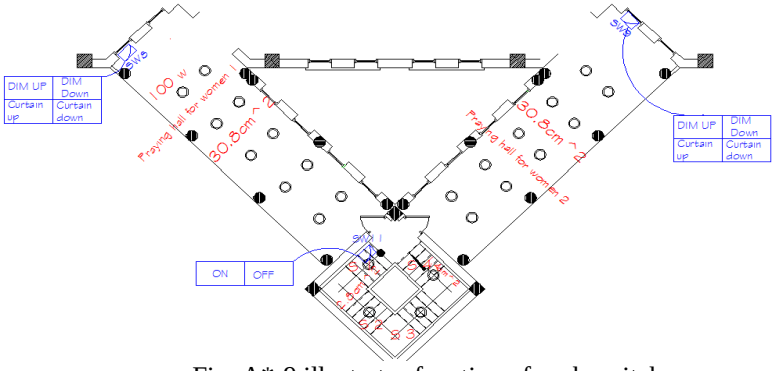

Fig. A*-9 illustrates function of each switch

Wiring of First floor with KNX:-

First step

-As shown in figure (B*-1) It is used two switch actuators (SW.3,SW.4) SW.3 has eight channels (ch.) to switch loads (L24 on ch.1,L25 on ch.2,L26 on ch.3,L27 on ch.5,L28 on ch.4,L33 on ch6,L32 on ch.7.L31 on ch.8)on and off & SW.4 has four channels to switch loads(L30 on ch.1,L29 on ch.2) on and off.
-It is used also blind actuator which has four channels (ch.) to control movement of blinds (L38 on ch.1, L37 on ch.2,L35 on ch.3,L36 on ch.4) up and down .

Fig. B*-1 illustrates controlled loads and actuator type that was used in each load

-As shown in figure (B*-2) It is used switch actuator (SW.4) which has four channels to switch load (stairs) on and off.

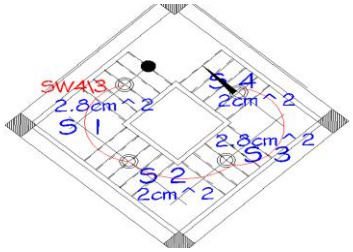

Fig. B*-2 illustrates controlled loads and actuator type that was used in each load

The following table illustrates wattage and number of channels in each type of actuator &function of each switch in first floor.

Actuator type	**Connection power maximum**	**Number of channels**
Switch actuator 3(sw.)	**1380(In)**	**8**
Switch actuator 4(sw.)	**2000(In)**	**4**
Blind actuator 3(BD)	**----**	**4**

	Sw12	**Sw12**	**Sw12**	**Sw12**	**Sw13**	**Sw13**	**Sw13**
	Sw. On	**Sw. Off**	**Curtain Up**	**Curtain Down**	**Sw. On**	**Sw. Off**	**Curtain Up**
L24 in wedding hall2	**	**					
L25 in wedding hall2	**	**					
L26 in wedding hall2	**	**					
L27 in wedding hall2	**	**					
L28 in wedding hall2	**	**					
L35 in wedding hall3			**	**			
L36 in wedding hall3			**	**			
L29 in wedding hall3					**	**	
L30 in wedding hall3					**	**	
L37 in wedding hall3							**
L38 in wedding hall3							**
	Sw13	**Sw14**	**Sw14**				
	Curtain Down	**Sw. On**	**Sw. Off**				
L37 in wedding hall3	**						
L38 in wedding hall3	**						
Stairs first floor		**	**				

Table B*

Second step:

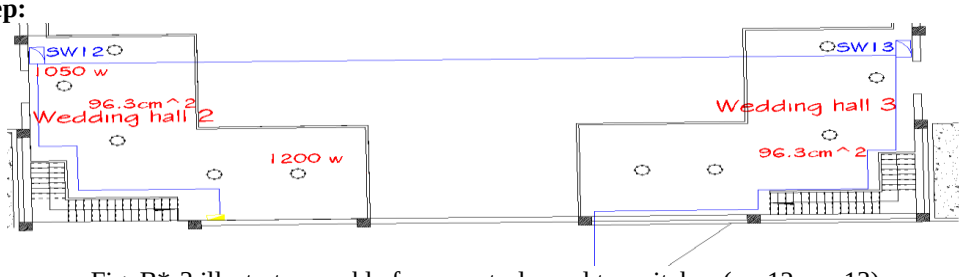

Fig. B*-3 illustrates a cable from control panel to switches (sw.12, sw.13)

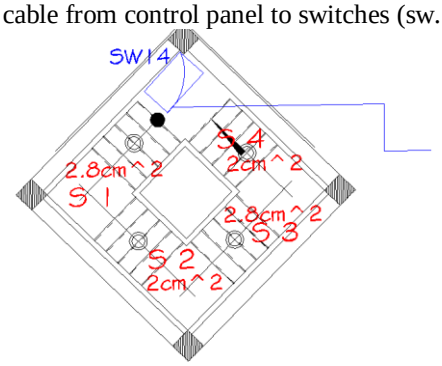

Fig. B*-4 illustrates a cable from sw.13 to sw.14

Third step:

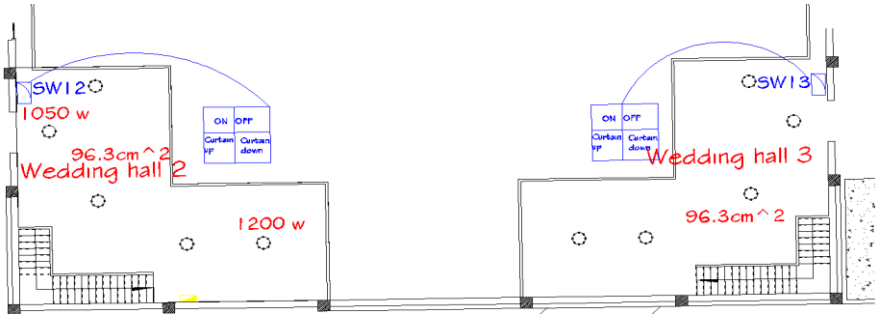

Fig. B*-5 illustrates function of each switch

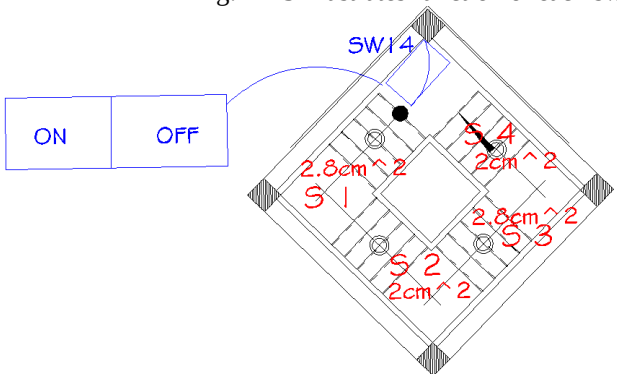

Fig. B*-6 illustrates function of each switch

-Wiring of Basement floor with KNX:-

First step

-As shown in figure (C*-1) It is used dimming actuator(DM11)which has one channel to reduce light and hence reduce energy at different times in day in load(praying hall for men).

-It is used switch actuator(SW.5) which has two channels(ch.) to switch loads(praying hall for men, stairs on ch.1)&(shower rooms,area2,men bathrooms,corridor1,corridor on ch.2) on and off.

-it is used two movement detectors(S2,S3) to sense movement in corridor& two movement detectors(S4,S5) to sense movement in corridor1.

It is used also blind actuator (BD4) which has two channels (ch.) to control movement of blinds(praying hall for men on ch.1) up and down .

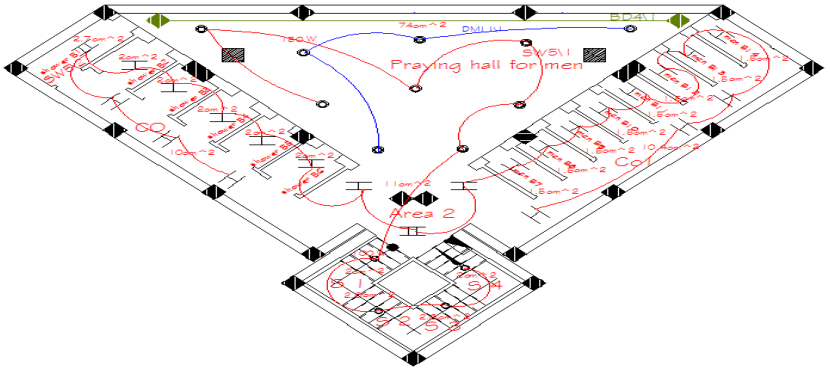

Fig. C*-1 illustrates controlled loads and actuator type that was used in each load

The following table illustrates wattage and number of channels in each type of actuator &function of each switch in basement floor.

Actuator type	Connection power maximum	Number of channels
Switch actuator 5(sw.)	2000(In),1800(F)	2
Dimming actuator 11(DM)	1000	1
Blind actuator 4(BD)	----	2

	Sw15	Sw15	Sw15	Sw15	Sw15	Sw15
	Sw. On	Sw. Off	Curtain Up	Curtain Down	Dimming Up	Dimming Down
Praying hall for men	**	**			**	**
Stairs basement floor	Off	Off				
L39 in praying hall for men			**	**		
	Sw16	Sw16	Sw17	Sw17	Sw18	Sw18
	Sw On	Sw. Off	Sw. On	Sw. Off	Sw. On	Sw. Off
Area2	Off	Off	Off	Off	Off	Off
ShowerB1	**	**	Off	Off	Off	Off
ShowerB2	Off	Off	**	**	Off	Off
ShowerB3	Off	Off	Off	Off	**	**
ShowerB4	Off	Off	Off	Off	Off	Off
ShowerB5	Off	Off	Off	Off	Off	Off
ShowerB6	Off	Off	Off	Off	Off	Off
MenB7	Off	Off	Off	Off	Off	Off
MenB8	Off	Off	Off	Off	Off	Off
MenB9	Off	Off	Off	Off	Off	Off
MenB10	Off	Off	Off	Off	Off	Off
MenB11	Off	Off	Off	Off	Off	Off
MenB12	Off	Off	Off	Off	Off	Off
MenB13	Off	Off	Off	Off	Off	Off
MenB14	Off	Off	Off	Off	Off	Off
	Sw19	Sw19	Sw20	Sw20	Sw21	Sw21
	Sw. On	Sw. Off	Sw. On	Sw. Off	Sw. On	Sw. Off
Area2	Off	Off	Off	Off	Off	Off
ShowerB1	Off	Off	Off	Off	Off	Off
ShowerB2	Off	Off	Off	Off	Off	Off
ShowerB3	Off	Off	Off	Off	Off	Off
ShowerB4	**	**	Off	Off	Off	Off
ShowerB5	Off	Off	**	**	Off	Off
ShowerB6	Off	Off	Off	Off	**	**
MenB7	Off	Off	Off	Off	Off	Off
MenB8	Off	Off	Off	Off	Off	Off
MenB9	Off	Off	Off	Off	Off	Off
MenB10	Off	Off	Off	Off	Off	Off
MenB11	Off	Off	Off	Off	Off	Off
MenB12	Off	Off	Off	Off	Off	Off
MenB13	Off	Off	Off	Off	Off	Off
MenB14	Off	Off	Off	Off	Off	Off
	Sw22	Sw22	Sw23	Sw23	Sw24	Sw24
	Sw. On	Sw. Off	Sw. On	Sw. Off	Sw. On	Sw. Off
Area2	Off	Off	Off	Off	Off	Off
ShowerB1	Off	Off	Off	Off	Off	Off
ShowerB2	Off	Off	Off	Off	Off	Off
ShowerB3	Off	Off	Off	Off	Off	Off
ShowerB4	Off	Off	Off	Off	Off	Off

ShowerB5	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB6	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB7	**	**	**Off**	**Off**	**Off**	**Off**
MenB8	**Off**	**Off**	**	**	**Off**	**Off**
MenB9	**Off**	**Off**	**Off**	**Off**	**	**
MenB10	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB11	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB12	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB13	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB14	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
	Sw25	**Sw25**	**Sw26**	**Sw26**	**Sw27**	**Sw27**
	Sw. On	**Sw. Off**	**Sw. On**	**Sw. Off**	**Sw. On**	**Sw. Off**
Area2	**Off**	**Off**	**Off**	**Off**	**	**
ShowerB1	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB2	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB3	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB4	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB5	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB6	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB7	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB8	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB9	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB10	**	**	**Off**	**Off**	**Off**	**Off**
MenB11	**Off**	**Off**	**	**	**Off**	**Off**
MenB12	**Off**	**Off**	**Off**	**Off**	**	**
MenB13	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB14	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
	Sw28	**Sw28**	**Sw29**	**Sw29**	**Sw31**	**Sw31**
	Sw. On	**Sw. Off**	**Sw. On**	**Sw. Off**	**Sw. On**	**Sw. Off**
Area2	**Off**	**Off**	**Off**	**Off**	**	**
ShowerB1	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB2	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB3	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB4	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB5	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
ShowerB6	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB7	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB8	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB9	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB10	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB11	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB12	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**
MenB13	**	**	**Off**	**Off**	**Off**	**Off**
MenB14	**Off**	**Off**	**	**	**Off**	**Off**
	Sw30	**Sw30**		**S2,S3**		**S4,S5**
	Sw. On	**Sw. Off**				
Praying hall for men	**Off**	**Off**	**Corridor**	**Detect movement**	**Corridor1**	**Detect movement**
Stairs basement floor	**	**				
			Area2	**Off**		**Off**
			ShowerB1	**Off**		**Off**
			ShowerB2	**Off**		**Off**
			ShowerB3	**Off**		**Off**
			ShowerB4	**Off**		**Off**
			ShowerB5	**Off**		**Off**
			ShowerB6	**Off**		**Off**
			MenB7	**Off**		**Off**
			MenB8	**Off**		**Off**
			MenB9	**Off**		**Off**
			MenB10	**Off**		**Off**
			MenB11	**Off**		**Off**
			MenB12	**Off**		**Off**
			MenB13	**Off**		**Off**
			MenB14	**Off**		**Off**

Table C*

Second step:

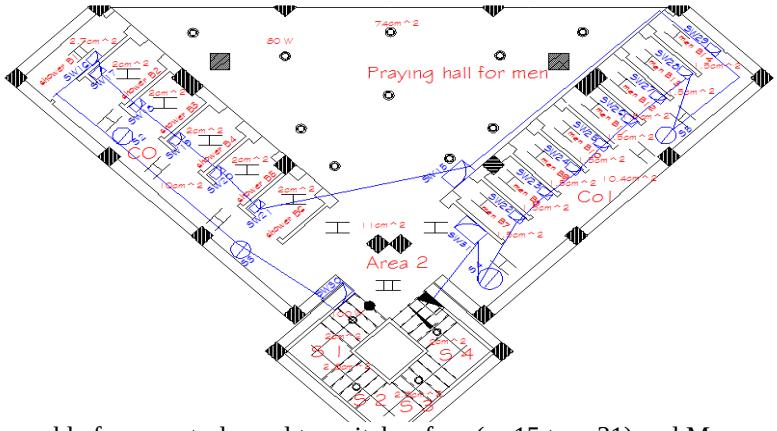

Fig. C*-2 illustrates a cable from control panel to switches from(sw15 tosw31) and Movement detector (S2,S3,S4,S5)=u74

Third step:

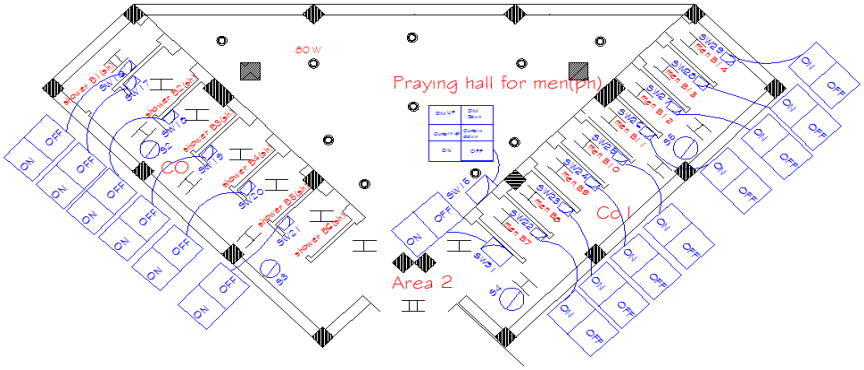

Fig. C*3 illustrates function of each switch

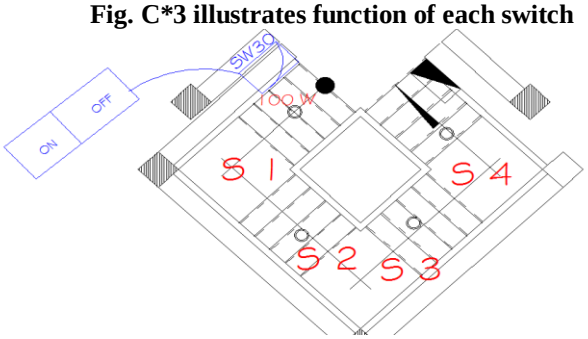

Fig. C*-4 illustrates function of each switch

7.8 -Calculation of energy cost with KNX protocol.[7]

Assume price of KW=0.3L.E
Total consumption per day= sum of (kw.hours) of rooms*0.3
Ground floor
In Wedding hall (12150w)
Assume it works 8 hours
First 2hours consume 100%=12150w
And 6hours consume 80% bye dimming 20%=9720w
The power consumed per month= (12150*2+6*972o)*30(day) /1000=2478.6kw
In Office& Area9 (500w)
Assume it works 8 hours
First 2hours consume 100%=500w
And 6hours consume 80% bye dimming 20%=400w
The power consumed per month= (2*500+6*400)*30(day) /1000=102kw

In Area3 (6600w)
Assume it works 8 hours
First 1hours consume 100%=6600w
And 7hours consume 80% bye dimming 20%=5280w
The power consumed per month= (6600+7*5280)*30(day) /1000=1306.8kw
In Entrance&WomenB1, B2, B3& Women ablution (560w)
Assume it works 8 hours
The power consumed per month = (8*560)*30(day) /1000 =134.4kw
In Conference (750w)
Assume it works 8 hours
First 1hours consume 100%=750w
And 7hours consume 80% by dimming 20%=600w
The power consumed per month = (750+7*600)*30(day) /1000=148.5kw
In Praying hall for women1or2 (1000w)
Assume it works 8 hours
First 3hours consume 100%=1000w
And 5hours consume 80% by dimming 20%=800w
The power consumed per month = (3*1000+5*800)*30(day) /1000=210kw
In Stairs (400w)
Assume it works 8 hours
The power consumed per month = (8*400)*30(day) /1000 =96kw
First floor
In Wedding hall 2or3 (5850w)
Assume it works 8 hours
the power consumed per month = (8*5850)*30(day) /1000 =1404kw
In Stairs (400w)
Assume it works 8 hours
The power consumed per month = (8*400)*30(day) /1000=96kw

Basement floor
In Praying hall for men& Stairs (1500w)
Assume it works 8 hours
First 1hours consume 100%=1500w
And 7hours consume 80% by dimming 20%=1200w
The power consume per month d = (1*1500+1200*7)*30(day) /1000 =297kw
In Shower rooms& Men bathrooms&Area2&Corridor& Corridor1 (1000w)
Assume it works 8 hours
The power consumed per month = (1000*8)*30(day) /1000 =240kw
In Stairs (400w)
Assume it works 8 hours
The power consumed per month = (400*8)*30(day) /1000 =96kw
Total consumption=8223.3*0.3=2466.99L.E
The payments for first month= total consumption +price of the actuators
Price of actuator [assumed] is shown below

Number of actuator	Type of actuator	Price of actuator
4	Dimming actuator1*1000watt	400L.E
1	Dimming actuator 1*500watt	250L.E
6	Dimming actuator 1*1600watt	300L.E
2	Switch actuator 1380W, 8*230*6 A	500L.E
3	Switch actuator 2000W In,1800W F, 2*230*10 A	200L.E
2	blind actuator 4*6 A	100L.E
2	blind actuator 2*10 A	100L.E
5	Movement detectors	350L.E

Table9-1 illustrates price of actuator

Cost of devices=7400L.E
The payments for first month= (total consumption) + cost of devices= 9866.99L.E
(Cause of price of devices is paid in the first month)
The payments for other month=total consumption=2466.99L.E

7.9. Calculation of energy cost without KNX protocol.
Assume price OF KW=0.3L.E
Total consumption per month = sum of (kw.hours) of each room*0.3

Ground floor
In Wedding hall (12150w)
Assume it works 8 hours
The power consumed per month = (12150*8) *30(day) /1000=2916kw
In Office& Area9 (500w)

Assume it works 8 hours
The power consumed per month = (8*500)*30(day) /1000=120kw
In Area3 (6600w)
Assume it works 8 hours
The power consumed per month = (6600*8)*30(day) /1000 =1584kw
In Entrance&WomenB1, B2, B3& Women ablution (560w)
Assume it works 8 hours
The power consumed per month = (8*560)*30(day) /1000 =134.4kw
In Conference (750w)
Assume it works 8 hours
The power consumed per month = (8*750)*30(day) /1000 =180 kw
In Praying hall for women1&STAIRS 1, 2 or2& Praying hall for women2& Stairs 3,4(1200w)
Assume it works 8 hours
The power consumed per month = (8*1200)*30(day) /1000 =288kw
In Stairs (400w)
Assume it works 8 hours
The power consumed per month = (8*400)*30(day) /1000 =96kw

First floor
In Wedding hall 1or2 (5850w)
Assume it works 8 hours
the power consumed per month =(8*5850)*30(day) /1000 =1404kw
In Stairs (400w)
Assume it works 8 hours
The power consumed per month =(8*400)*30(day) /1000 =96kw

Basement floor
In Praying hall for men (1500w)
Assume it works 8 hours
The power consumed per month = (8*1500)*30(day) /1000=360kw
In Shower rooms&Corridor&Corridor1&Area2&Men bathrooms (1000w)
Assume it works 8 hours
The power consumed per month = (8*1000)*30(day) /1000 =240kw
In Stairs (400w)
Assume it works 8 hours
The power consumed per month = (400*8)*30(day) /1000 =96kw
Total consumption=total power consumed*0.3=2761.92L.E

10 Comparison between cost of each place in mosque with& without KNX protocol.

Table11-1 illustrates cost of each place with& without KNX per month.

Place	Cost with KNX	Cost without KNX
Wedding hall	743.58	874.8
Office&Area9	30.6	36
Area3	392.04	475.2
Entrance&WomenB1,B2,B3&Women ablution	40.32	40.32
Conference	44.55	54
Praying hall for women1	63	86.4
Praying hall for women2	63	86.4
Stairs ground floor	28.8	28.8
Wedding hall 2	421.2	421.2
Wedding hall 3	421.2	421.2
Stairs first floor	28.8	28.8
Praying hall for men& Stairs	89.1	108
Shower rooms& Men bathrooms&Area2&Corridor&Corridor1	72	72
Stairs basement floor	28.8	28.8

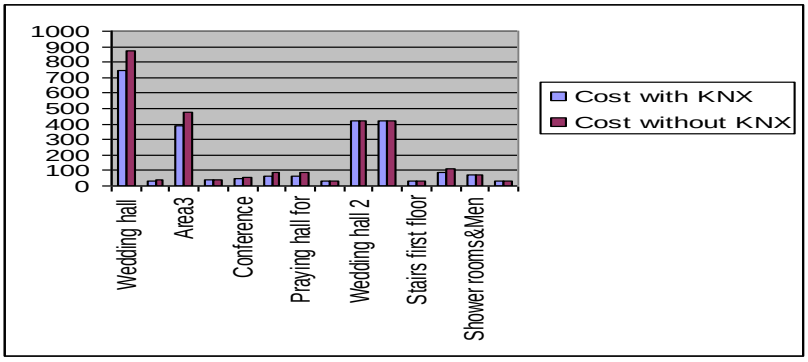

Fig.11-1 compares cost with& without KNX per month.

CONCLUSIONS

Smart homes are for sure an upcoming challenge. If research works trend to explore and share promising results concerning this concept, adoption by industry would imply many efforts.

We have presented in this article our responses to adoption efforts. We think that using the KNX model, in particular the Easy Mode specifications, eases the integration of existing technologies and services into a single, open and standardized system. Even more, this model can ease market adoption, by abstracting home automation hardware and focusing on end user services.

By applying the wiring rules according to the Egyptian code and IEE Wiring regulation, this design is considered as a safety and economical design.

Applying KNX Protocol in this Mosque drops the total cost, but actually this save in power and for sure in money in small building like Mosque or either a house isn't as effective as in large buildings like mall for example.

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